Astronomy 101
Monday, Wednesday, Friday
10:10 – 11:00 am

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Homework due Today (May 12)

- Make up a test question for next test
- Multiple Choice
- A-E possible answers
- 1 point for handing it in
- 1 point for me using it on test
- The question needs to be on material that will be on the next exam
- You will not get credit if it is handed in after I make up the exam

Schedule

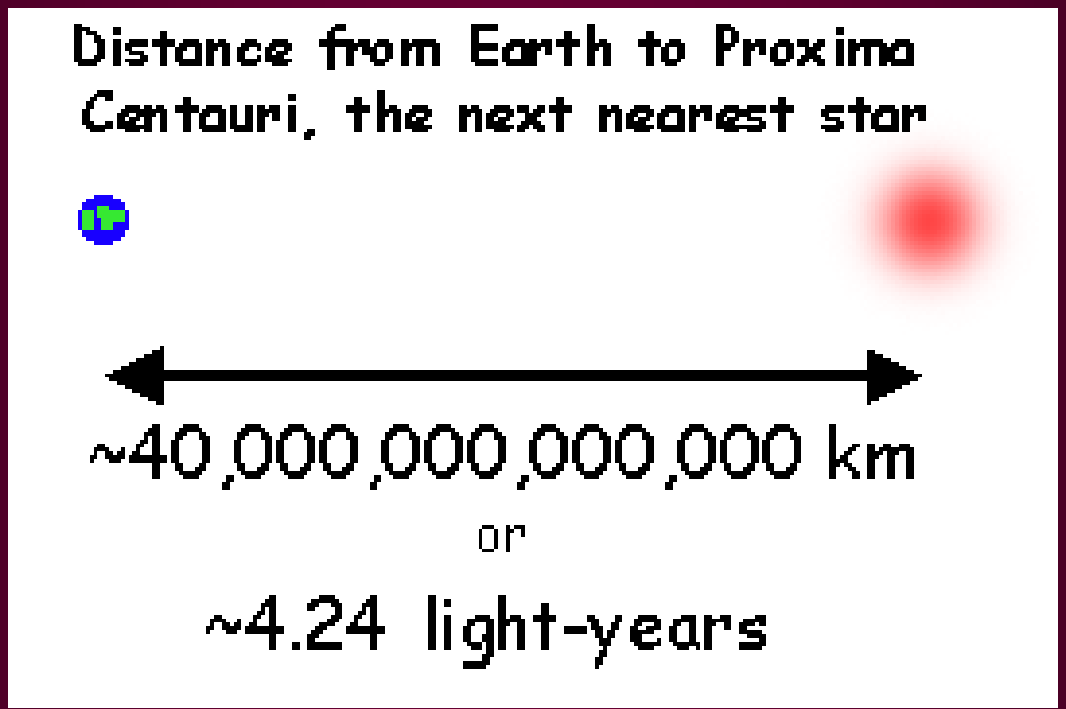
- Today – Extrasolar Planets
- Monday (15^{th}) – Is there Life out there?
- Tuesday (16^{th}) - 6 pm – Review – Hasbrouck 134
- Wednesday (17^{th}) – 4^{th} Exam
  - Other room – Hasbrouck 109
- Wednesday (24^{th}) – 1:30 pm- Optional Final and Makeup Test for Exam 2 or 3 or 4 – Hasbrouck 20

If you want to find life outside our solar system

- You need to find planets
- http://exoplanet.eu

Things to Remember

- The Milky Way has at least 200 billion other stars and maybe as many as 400 billion stars
- Jupiter's mass is 318 times than the mass of the Earth



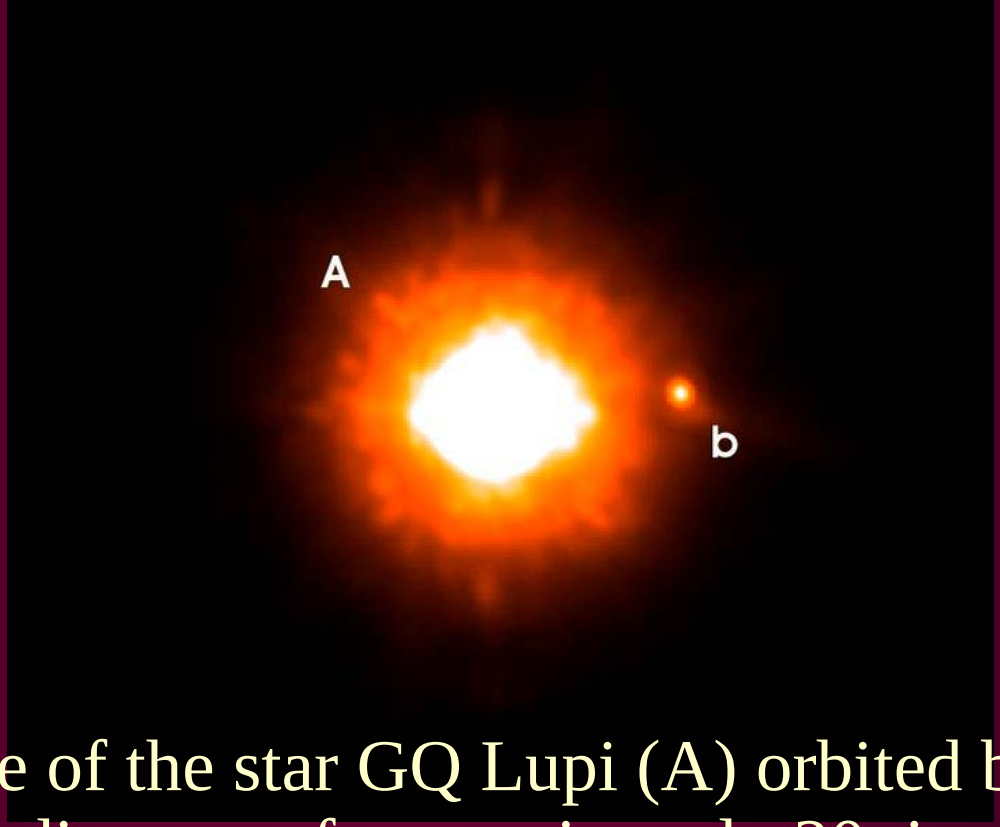
Question:

- How many of these stars have planets?

What is the problem when looking for planets?

What is the problem when looking for planets?

- The stars they orbit are much, much brighter than the planets



- Infrared image of the star GQ Lupi (A) orbited by a planet (b) at a distance of approximately 20 times the distance between Jupiter and our Sun.
- GQ Lupi is 400 light years from our Solar System and the star itself has approximately 70% of our Sun's mass.
- Planet is estimated to be between 1 and 42 times the mass of Jupiter.
- http://en.wikipedia.org/wiki/Image:GQ_Lupi.jpg

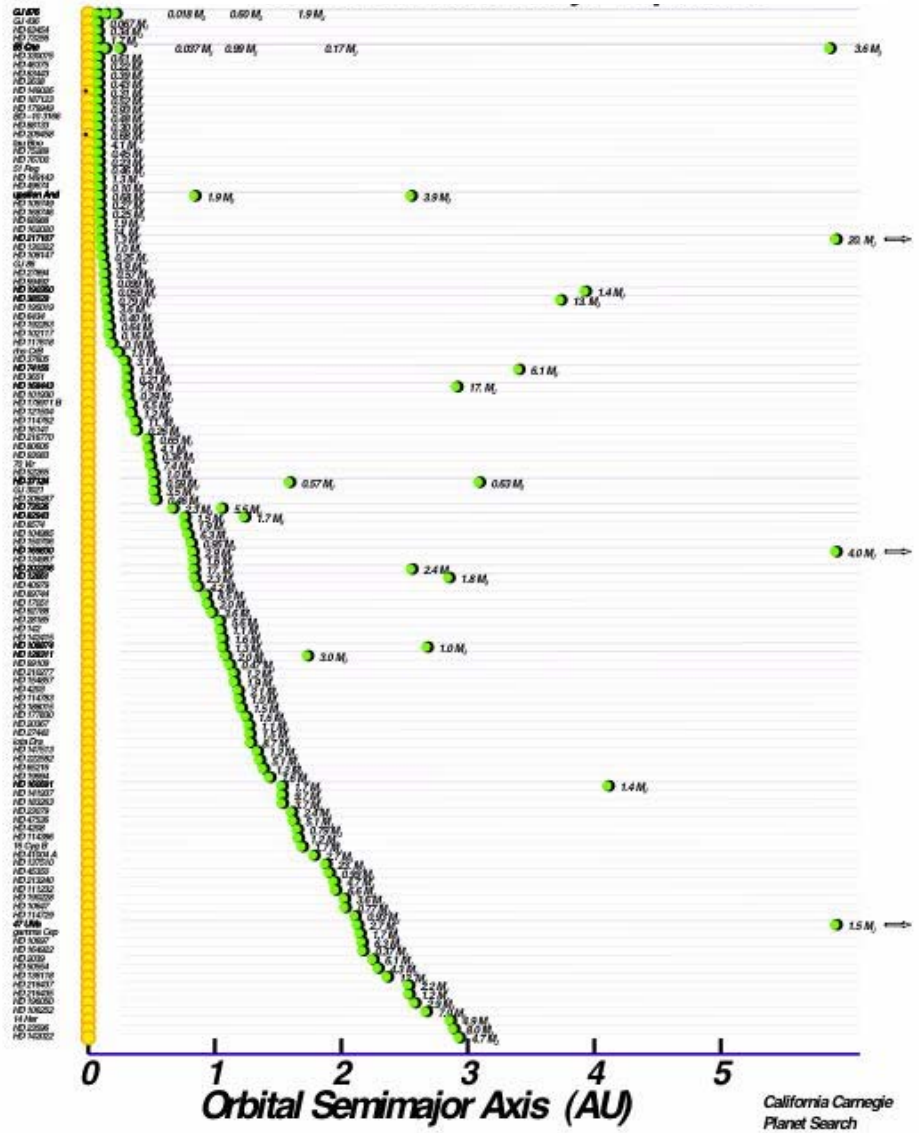
So what characteristics of the planets may allow you to “see” the planet

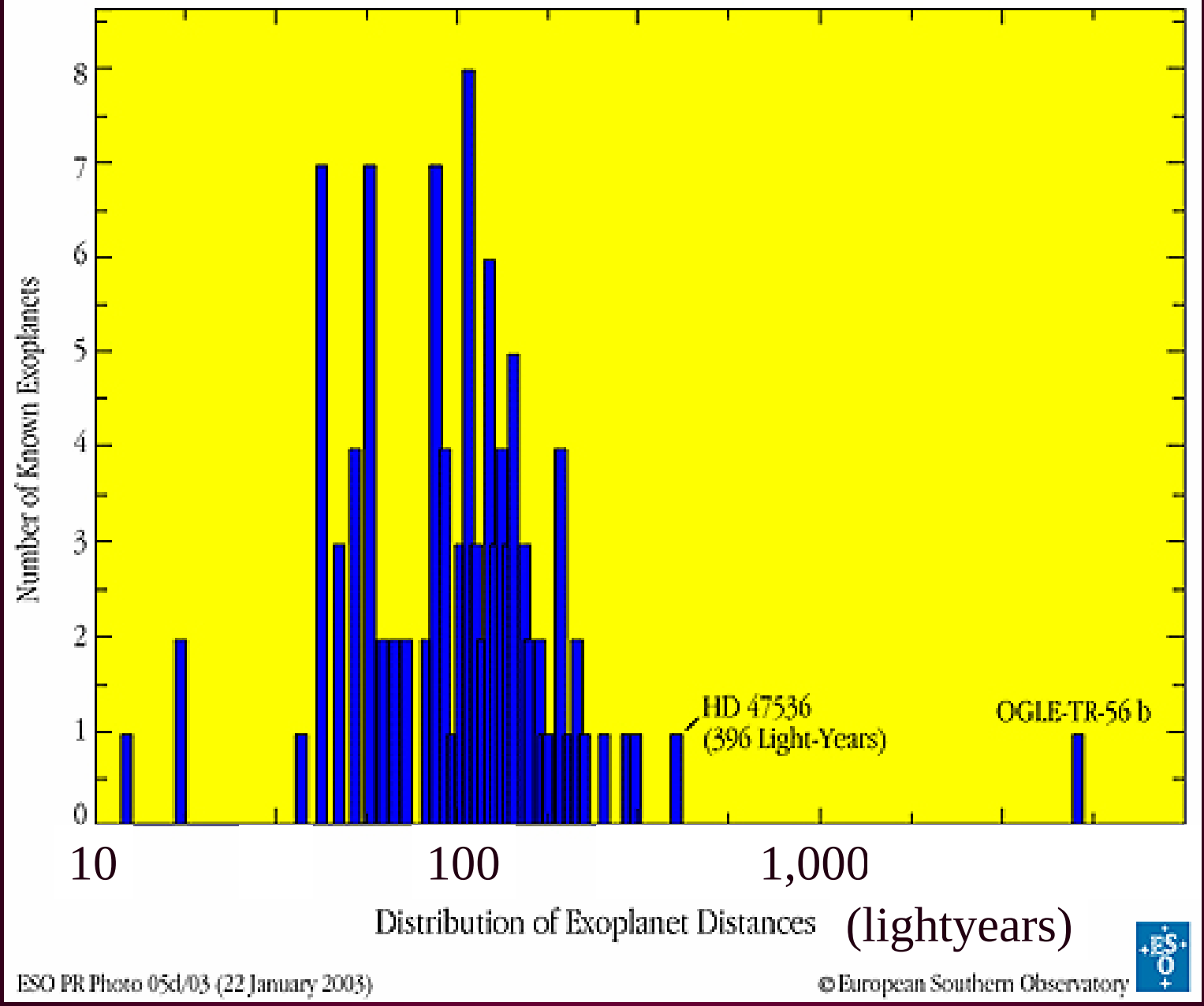
So what characteristics of the planets may allow you to “see” the planet

- Planets have mass
- Planets have a diameter
- Planets orbit the star

Over 180 known now

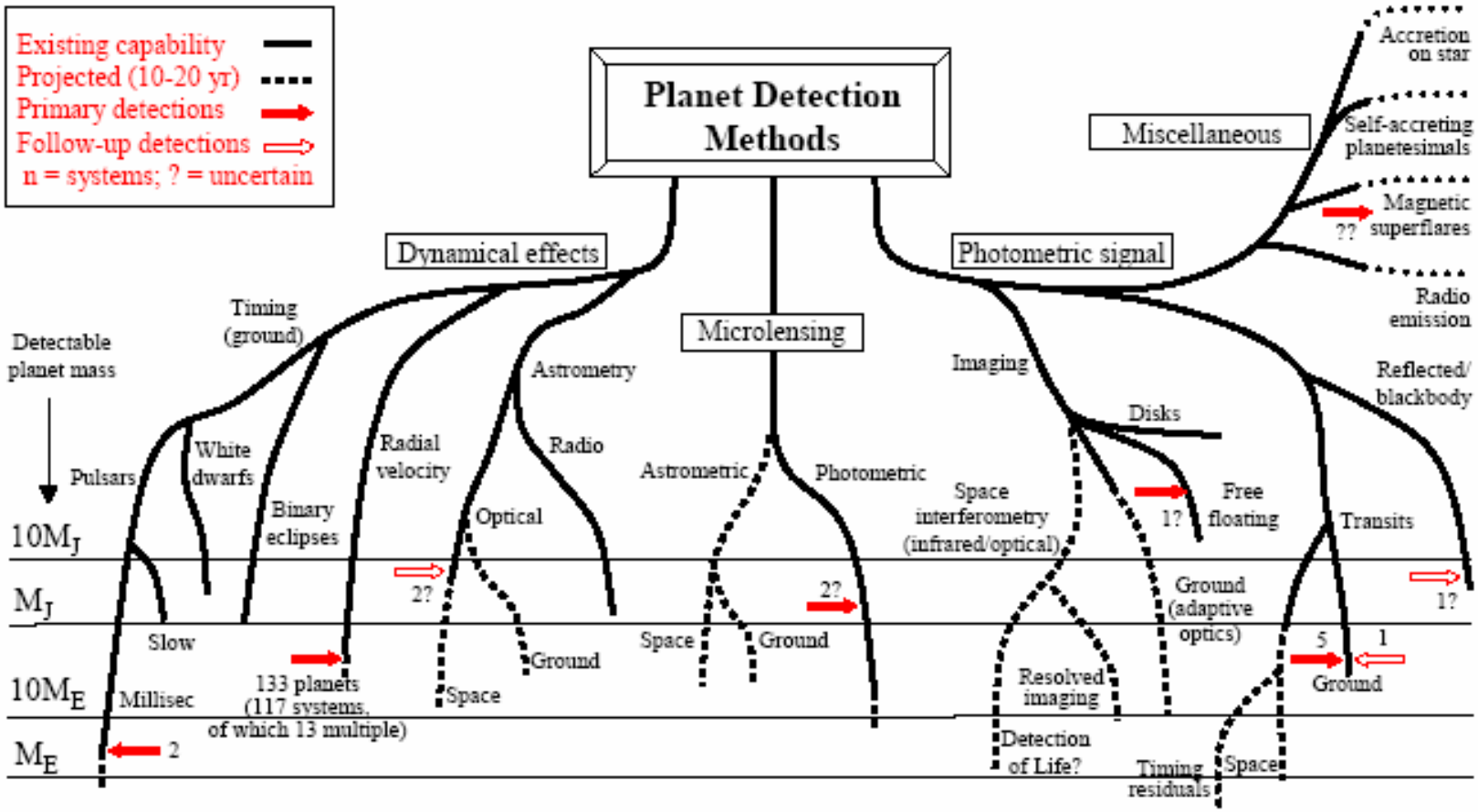
156 on graph




Number of Known Exoplanets
0
1
2
3
4
5
6
7
8
HD 47536
(396 Light-Years)
OGLE-TR-56 b
10
100
1,000
Distribution of Exoplanet Distances (lightyears)
ESO PR Photo 05cl/03 (22 January 2003)
© European Southern Observatory

Planet Detection Methods

Michael Perryman, Rep. Prog. Phys., 2000, 63, 1209 (updated November 2004)
[corrections or suggestions please to michael.perryman@esa.int]

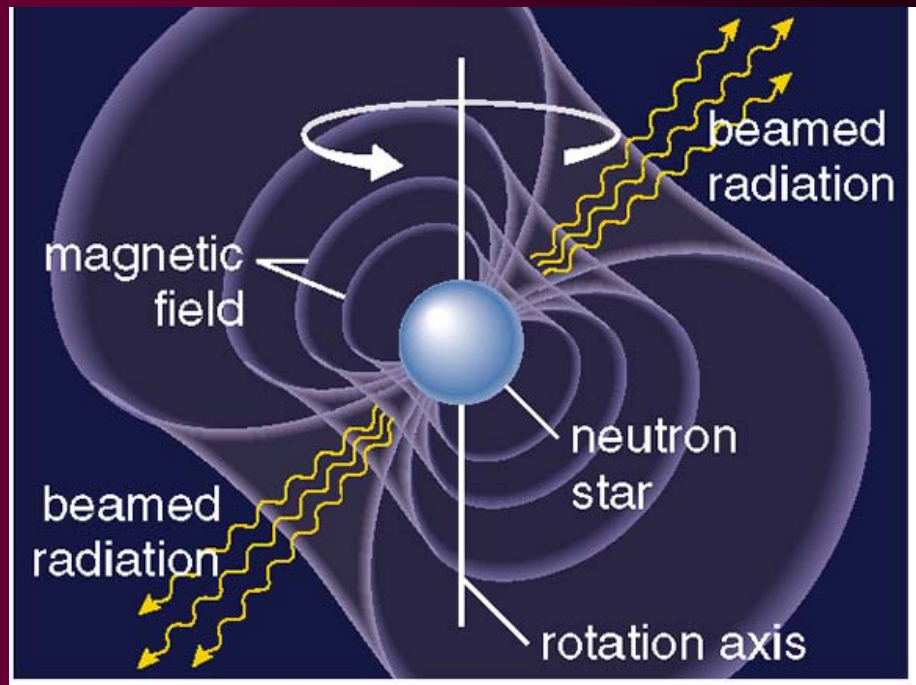


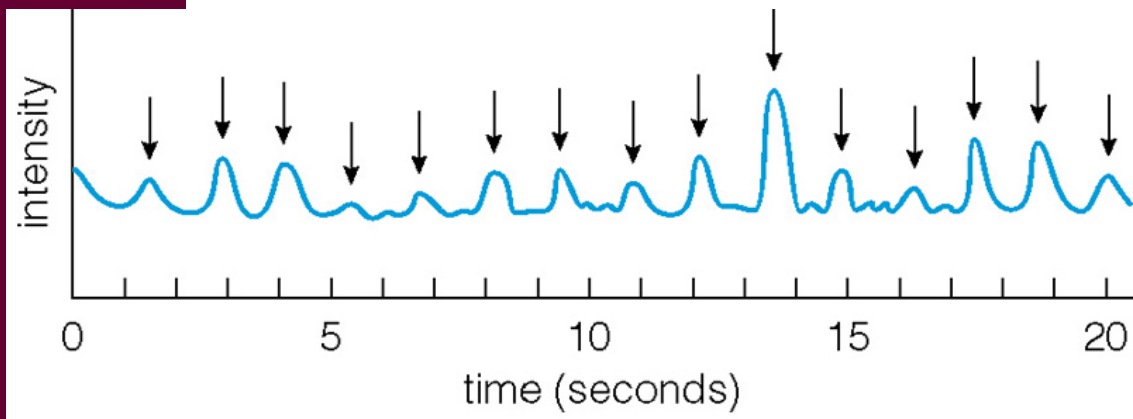
Some Possible Ways to detect Planets

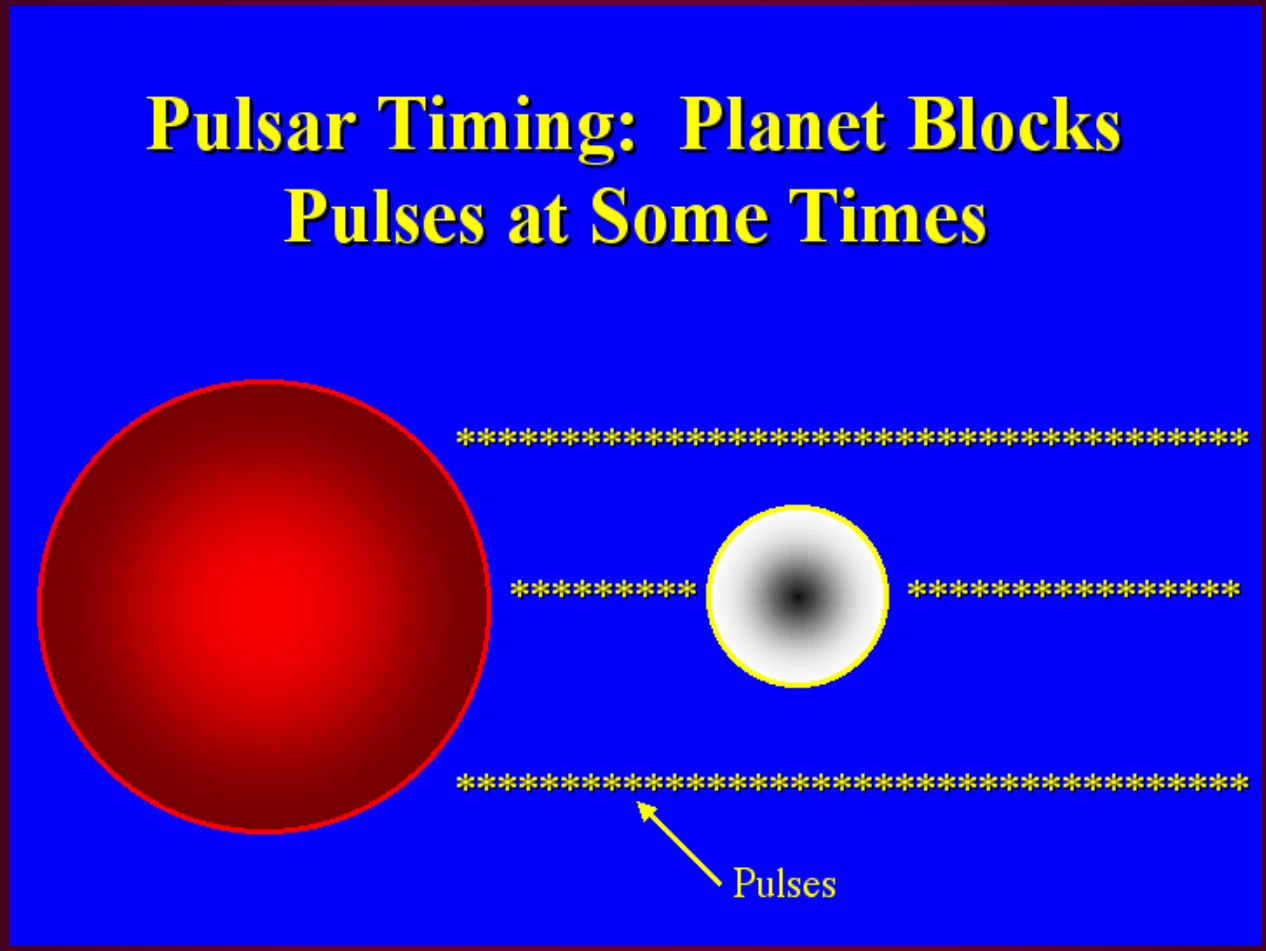
- Pulsar Timing
- Radial Velocity (Doppler Method)
- Transit Method
- Direct Observation

Pulsars

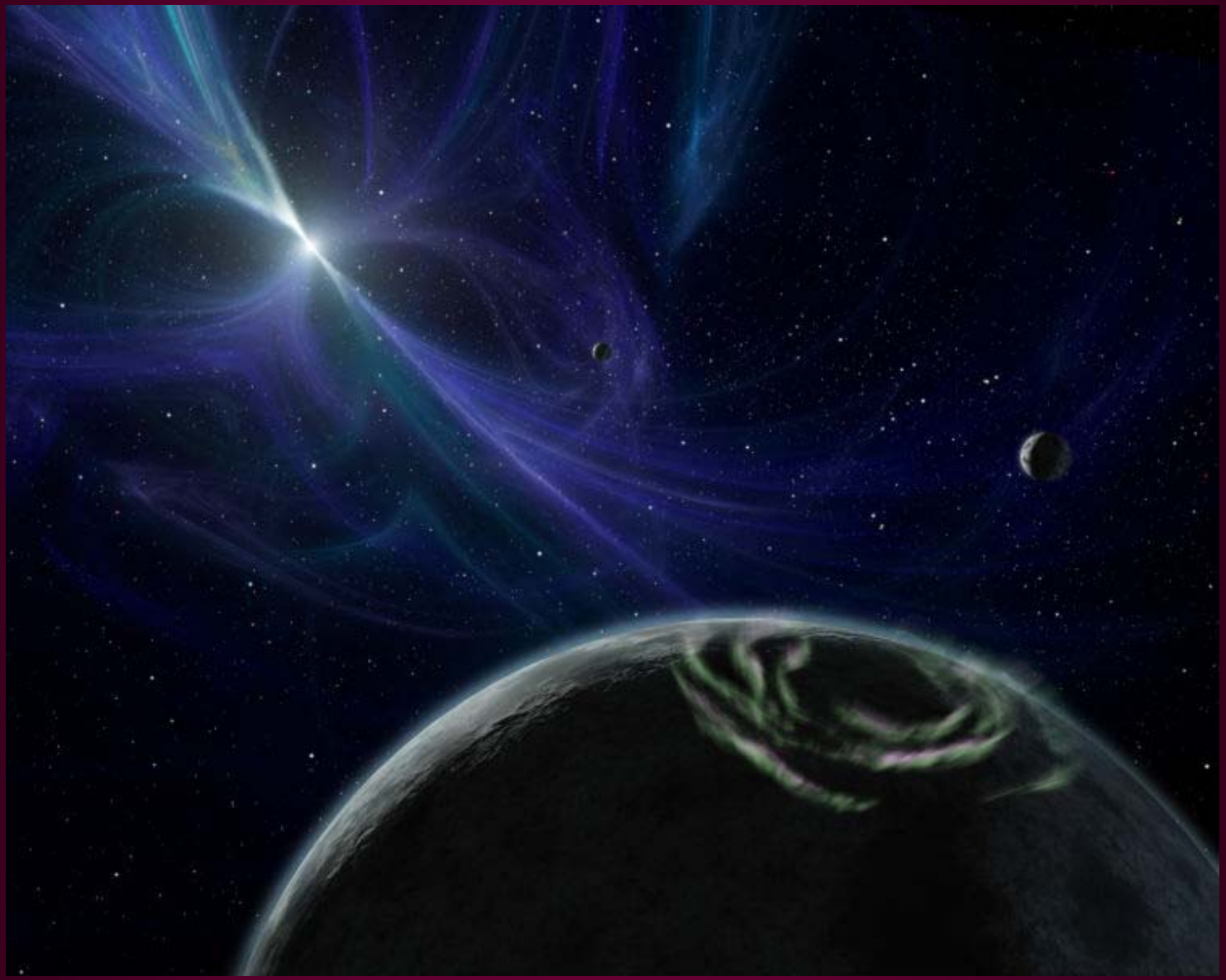
- Rotating Neutron Stars
- Have densities of
  8×10^{13} to 2×10^{15} g/cm³







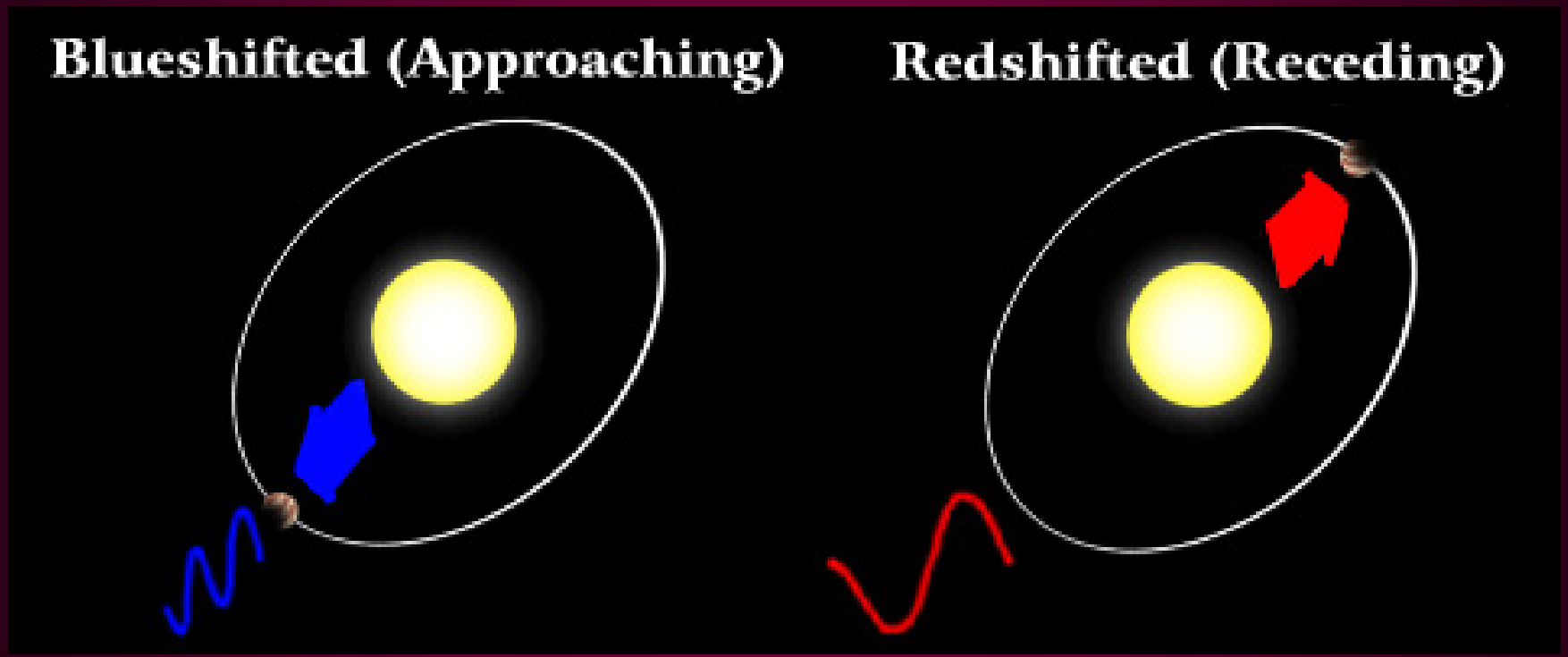
- http://www-learning.berkeley.edu/astrobiology/powerpointhtml/sld035.htm



- http://en.wikipedia.org/wiki/Image:Ssc2006-10c.jpg

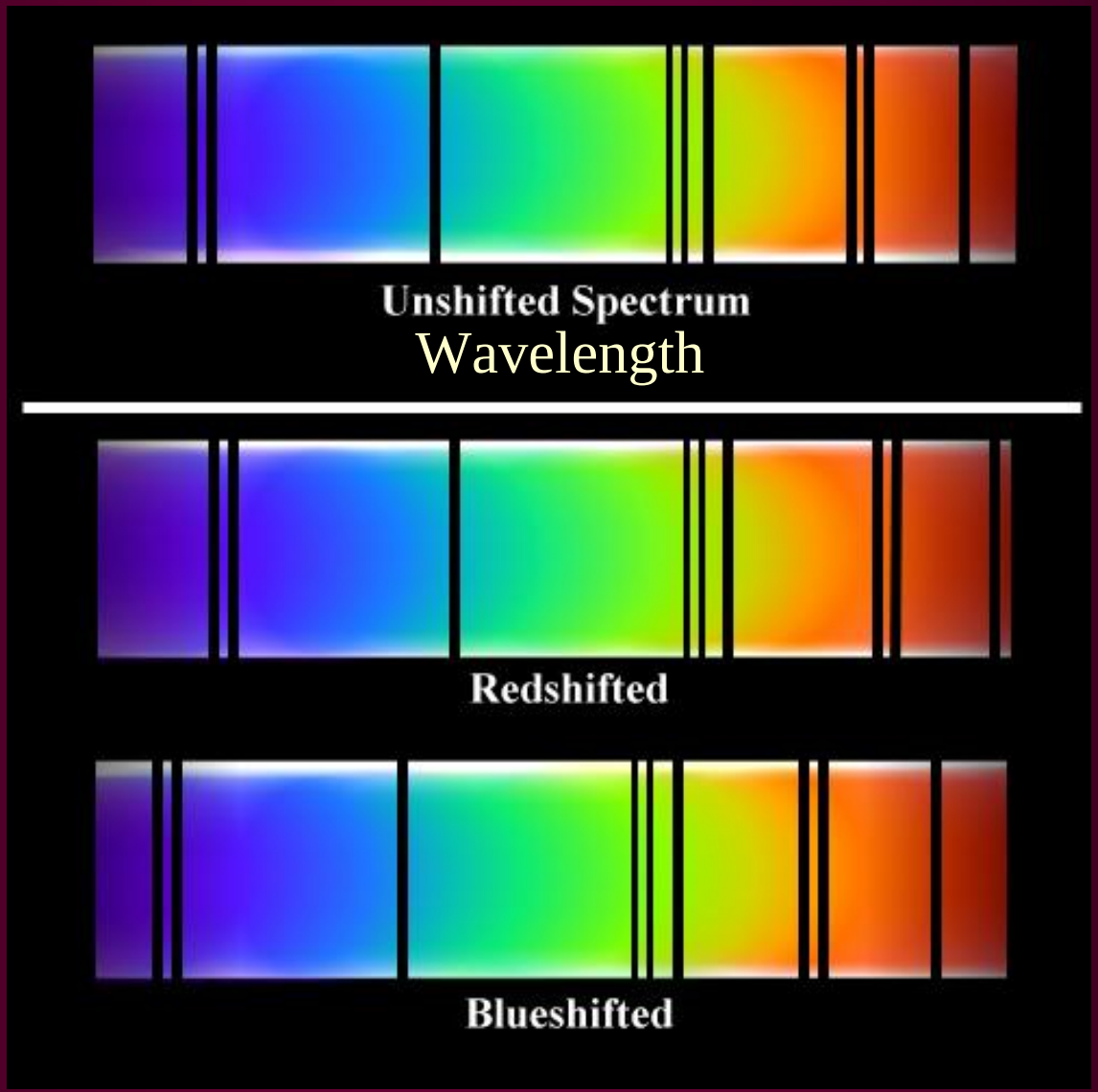
Would you want to live on a pulsar planet?

Radial Velocity (Doppler Method)

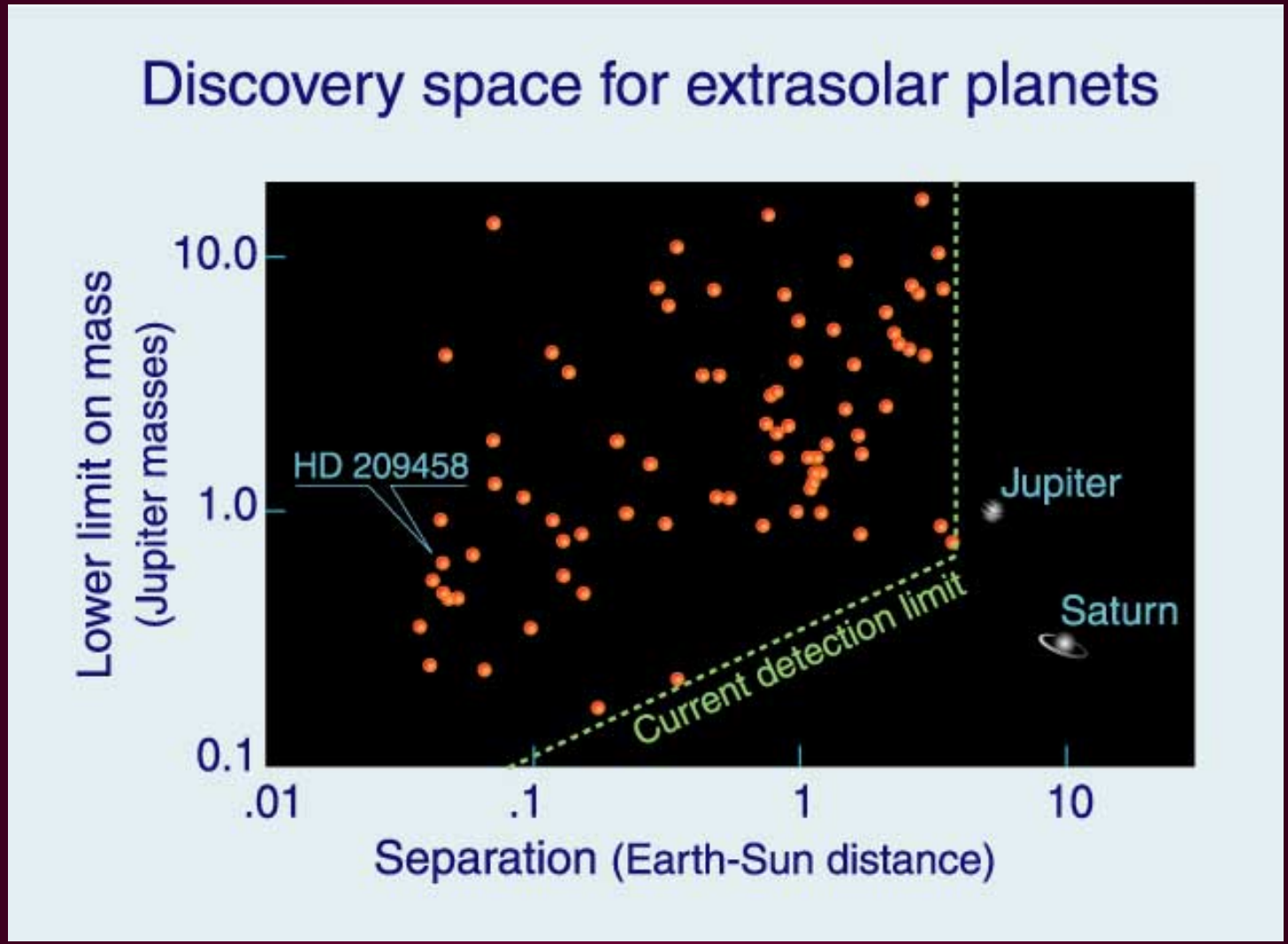


http://www.psi.edu/~esquerdo/asp/shifts.jpg

- http://astronautica.com/detect.htm



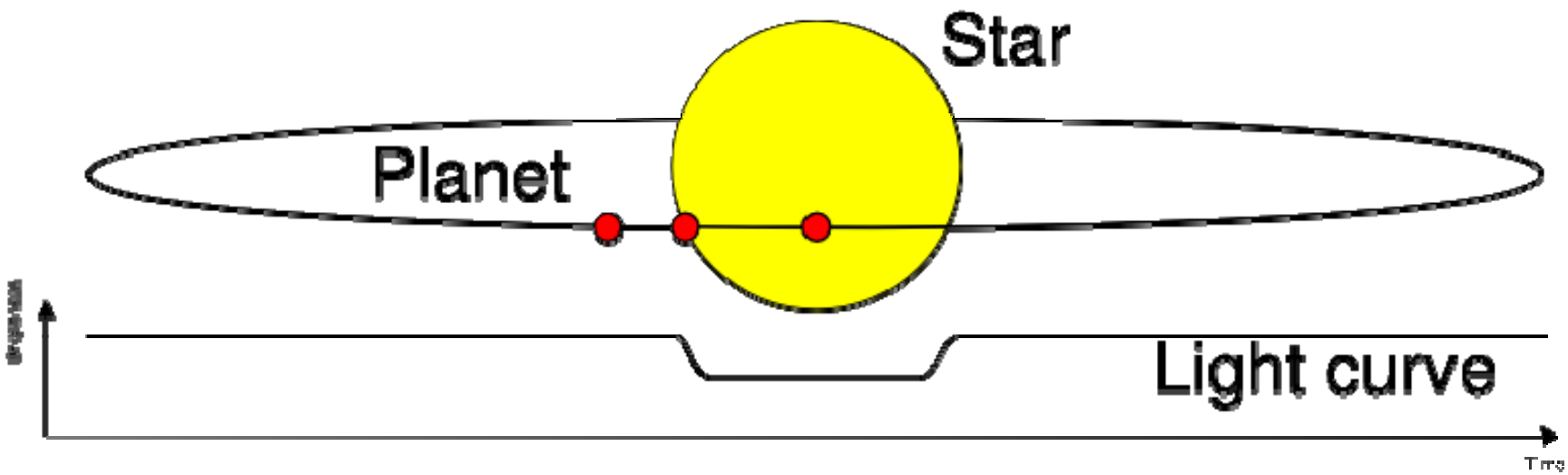
http://www.psi.edu/~esquerdo/asp/method.html



www.physics.brandeis.edu/powerpoint/Charbonneau.ppt

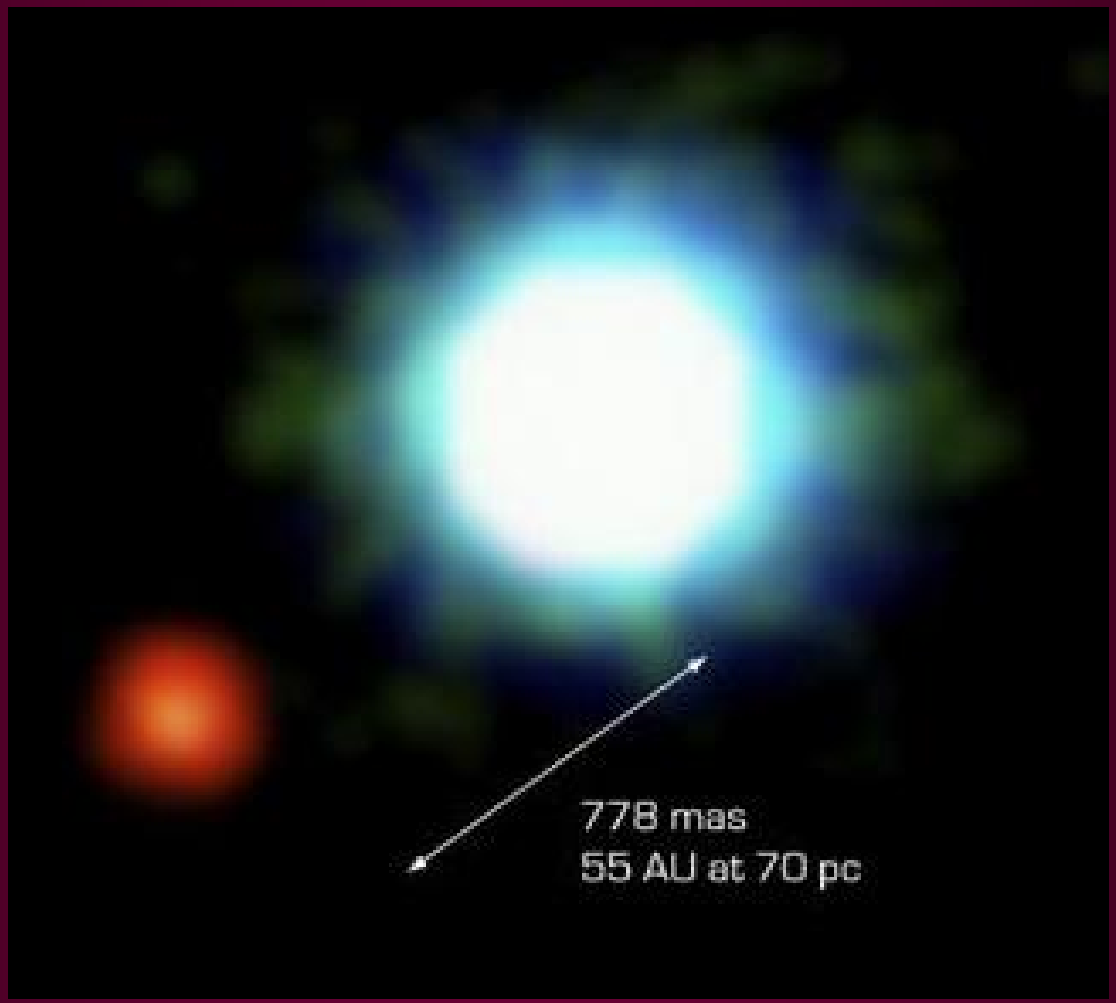
Transit Method

- When one celestial body appears to move across the face of another celestial body



- When the planet crosses the star's disk, the visual brightness of the star drops a small amount
- The amount the star dims depends on its size and the size of the planet.
- For example, in the case of HD 209458, the star dims 1.7%.
- http://en.wikipedia.org/wiki/Extrasolar_planets#Transit_method

Direct Observation

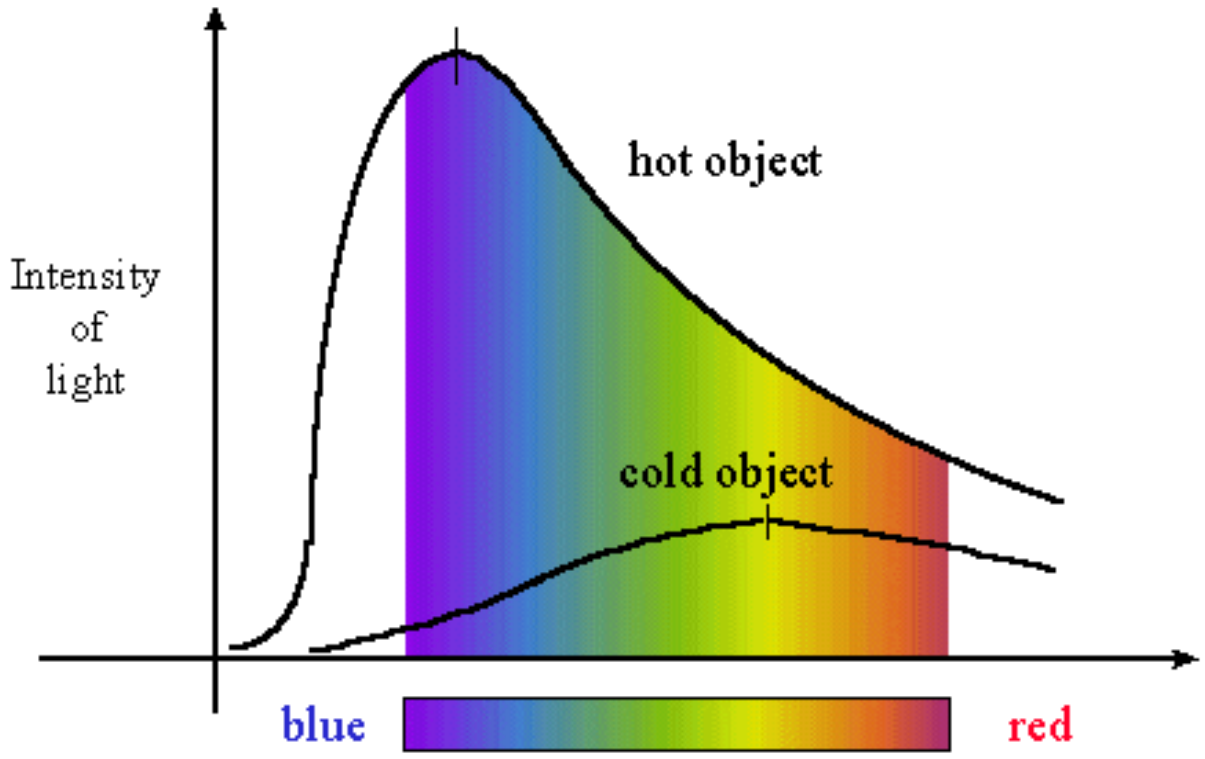


- Infrared Image

Visible Infrared

- http://www.news.cornell.edu/stories/March05/extrasolar.ws.html

Wien's Law



$$\text{Wavelength of Maximum Intensity (cm)} = \frac{.29}{T\ (^{\circ}K)}$$

- http://www.news.cornell.edu/stories/March05/Planet-eclipse-Plot.mov

Any Questions?